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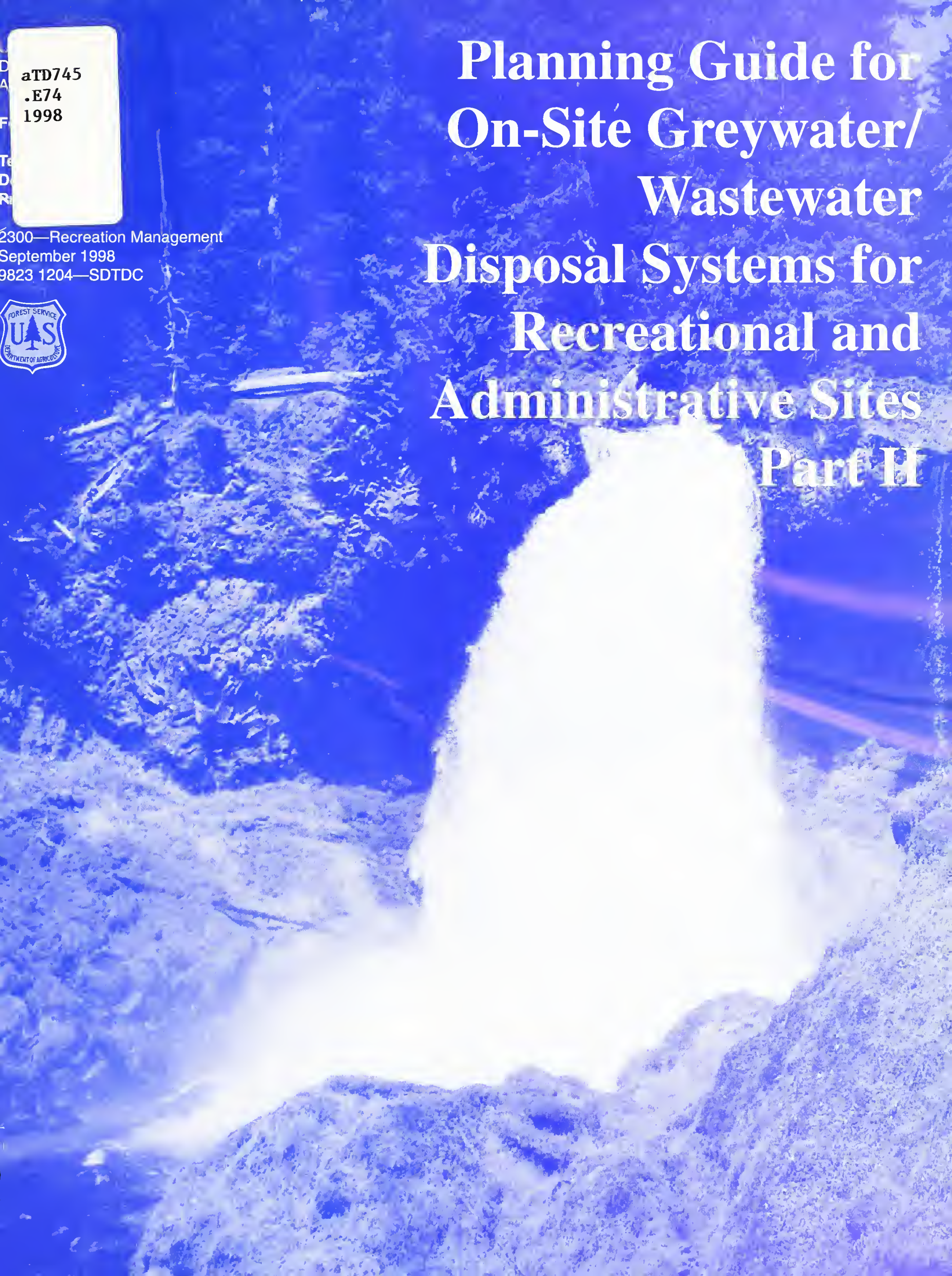
Planning Guide for On-Site Greywater/ Wastewater Disposal Systems for Recreational and Administrative Sites Part II



Planning Guide for On-Site Greywater/ Wastewater Disposal Systems for Recreational and Administrative Sites Part II

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PREFACE

This publication is intended to be used in conjunction with the *Planning Guide for On-Site Greywater Disposal Systems for Recreational and Administrative Sites* Publication No. 9523 1201 - SDTDC April 1995.

As a result of new treatment and disposal methods developed since the first guide was published, it was decided that a second publication detailing alternative methods was needed.

The information and data contained in this publication are based on actual field experience, research, and literature. All the information and technology used in the selection, installation, and operation of a sewage treatment system is adaptable to the treatment and disposal of greywater.

Greywater has a different composition than combined waste from conventional systems. It is entirely free of black waste pollutants and is more esthetically acceptable for on-site treatment. Also, it is far more economical to process in terms of equipment and space required. The examples included are meant to acquaint Forest Service personnel with acceptable alternative methods of wastewater treatment and are not intended to provide definitive design information. The treatment devices/methods described must be sized to the parameters for each particular site. Finally, all plans and specifications must be approved by the appropriate agencies, and adherence to codes is obligatory.

INTRODUCTION

This publication is intended to help the Recreation planner/designer. It lists the logical decisions that must be explored before constructing or renovating a campground or an administrative site wastewater facility. Also, it describes some of the newer methods of greywater/wastewater treatment that may be used at Forest Service sites.

The designer must realize the importance of including maintenance personnel in the preliminary processes to ensure consideration is given to the installation, maintenance, and operation of the system once it is in place.

The two main reasons for presenting new methods of wastewater disposal are diminishing supplies of good water and rapidly escalating costs of treating both potable and/or wastewater. Secondary reasons for disposing of greywater separately include extending the life of the existing wastewater system and rehabilitating an existing wastewater system that has already failed because of overuse.

The primary objective of this planning guide is to assist the designer in obtaining safe and adequate on-site wastewater treatment facilities and by accomplishing that to:

- Minimize the exposure of the public to the disease transmission potential of domestic waste
- Minimize the potential for contamination of drinking water supplies and hazards to recreational areas
- Reduce the potential for surface and groundwater pollution.

PLANNING CONSIDERATIONS

One of the problems in wastewater treatment and disposal is the public's perception of wastewater. The public regards any water that has been through a sewer pipe or subjected to some contamination as though its molecular structure has been degraded. An effective way to deal with the public's misconception is to separate or eliminate toilet waste from the main volume of the wastewater. One area of water conservation that is often overlooked is the potential for reuse of water on-site. For example, in the typical administrative site, approximately 34 percent of the water consumed is used in flushing of toilets. The remaining 66 percent of the water can be

recovered for reuse by on-site wastewater treatment and recycling systems and used for landscape irrigation and flushing of toilets and urinals. Whether disposed of to the soil or to the surface, wastewater will need to be treated according to its eventual reuse, including possibly for drinking.

It will be necessary, with some of the more visible methods of wastewater treatment, to include the public along with Federal, State, local agencies, and various environmental groups in the conceptual design phase. Be advised that it is **extremely** important to include the public in the planning group as mentioned above, since they may have some preconceived notions that are difficult to unseat.

Many Forest Service wastewater problems require innovative, creative, and cooperative solutions. A positive working environment is needed with water agencies, legislators, regulators, environmentalists, and the public. Together, new issues can be resolved by using new technologies and innovative approaches to water resources management.

PLANNING OPTIONS FOR A WASTEWATER DISPOSAL SYSTEM

The planning options discussed in this section can be used in any order.

Site Evaluation

Determine if the design can be accomplished at the proposed site. Look at the topography to determine drainage and severe slope areas. Is there any surface water? What are the soil characteristics? Soil is difficult to describe. It is even more difficult to interpret the meaning of the descriptions for onsite wastewater treatment systems. Four characteristics can provide a majority of the information needed to make interpretations. Soil color often relates to the natural moisture regime. Soil texture, structure and consistence relate to the wastewater infiltration system loading rate or sizing. Where is the ground water? Who else is affected by a sub-surface disposal field? What watersheds would be effected? What potable water sources are downstream? How far?

Determine Quality of Wastewater to be Treated or Disposed

Look at the design to determine the number of sites, the population-at-one-time (PAOT), and the number and type of fixtures to be installed. Check with the Forest and/or District to see if plans for expansion will be forthcoming. Plan for additional people anyway! Be sure to insist on the use of water conserving types of low-flow toilets, faucet flow restrictors, low-flow hose bibs, and low-flow shower heads. Use the Uniform Plumbing Code and the Forest Service Handbook (FSH 7409.11, Chapter 50) to size the system.

Determine the Characteristics of the Greywater

Campground visitors will generally use throw-away plates and cutlery so greywater generation from washing plates, spoons, and forks will be minimal. However, cooking utensils will be washed. Also, visitors are likely to pour cooking oil and grease (animal fat) into the greywater collection system, once installed, making the concentration of grease and oil comparable with greywater from a restaurant kitchen sink. Because of low usage of water at the campsites, the concentration of grease in the campground greywater is expected to be even higher than restaurant greywater.

The following table gives the average characteristics of restaurant greywater for estimating purposes. The true character of pollutant concentrations can only be determined through laboratory testing.

Table 1. Average concentrations (mg/L) of pollutants.

Pollutant	Kitchen
Chemical Oxygen Demand (COD)	1400 mg/L
Five-Day Biochemical Oxygen Demand (BOD3)	700 mg/L
Nitrogen compounds (NO3-N,NH3-N)	5 mg/L
Inorganic Phosphate (PO4)	10 mg/L
Suspended Solids	500 mg/L
Grease	750 mg/L

Review Applicable Guidelines for Disposal of Greywater

Most states require that greywater and blackwater (sewage) be handled in the same fashion as far as treatment and disposal are concerned. (Some revisions to this policy were discussed in the previous publication.) Federal, State, and local codes and regulations regarding the collection, storage, treatment, and disposal of wastewater must also be followed. Some states now require that wastewater treatment system designers be either a licensed sanitary engineer or have passed a state certification test.

Preliminary Planning Considerations

How much land area is available for wastewater treatment? Are climatic conditions acceptable for the type of system selected? Is there power available? Is there a sufficient quantity of water available at a high enough pressure? Is the campground or facility existing or only in the planning stages? Does the collection system need to be replaced? What ecological considerations must be addressed? Of the wastewater treatment alternatives addressed later in this publication, which one would provide the best choice for a particular site, at the lowest cost (both construction and maintenance/operation). All facilities should be designed for use by people with disabilities.

Select a Suitable Option

Select a wastewater system that:

- Meets the site requirement and the wastewater quality and characteristics to be treated and disposed of
- Is simple and dependable
- Minimizes the need for special skills to operate
- Is reasonable in cost to construct and maintain
- Complies with rules and regulations of Federal, State, and local agencies
- Is environmentally benign.

The following information is divided into two areas, treatment options and disposal options. Any of the treatment options can be used with any of the disposal options. How you utilize the two options together depends on the site specific conditions.

TREATMENT OPTIONS

The purpose of a treatment component is to transform the in-flowing raw wastewater into an effluent suited to the disposal component, thereby

allowing the wastewater to be disposed of in conformance with public health and environmental regulations. For example, in a subsurface soil absorption system, the pretreatment unit (e.g., septic tank) should remove nearly all settleable solids and floatable grease and scum so that a reasonably clear liquid is discharged into the soil absorption field. This allows the field to operate more efficiently. Likewise, for a surface discharge system, the treatment unit should produce an effluent that meets applicable surface discharge requirements.

Septic Tank Construction

Every user location should be retrofitted with a new tank, including those who have a tank in place from an existing septic system. The arguments for new tanks are compelling. The preponderance of septic tanks sold in the U.S. are structurally unsound and almost never watertight. Where groundwater levels are high, leaky tanks allow infiltration that can overburden a system's pumps and treatment facilities. Where high ground water is not a problem, leaky tanks ex-filtrate and the scum layer lowers to the discharge ports, causing solids and grease carryover and subsequent maintenance and pollution problems. In an effluent sewer, leaky tanks are unacceptable.

Septic Tank Filter

A septic tank filter (figure1) functions as a way to retain solids in the septic tank, improving the quality of the effluent and reducing the risk of clogging in lateral drainage pipes. The use of a septic tank filter can extend the life of the sub-surface absorption field. The filter is located within the outlet tee of the septic tank. The filter consists of a series of plastic mesh screens within a PVC housing. These finely spaced screens catch larger particle matter before it can escape the tank. The screens also provide a surface area on which microorganisms can grow which in turn break down effluent into basic elements and compounds.

The filters can effectively lower Total Suspended Solids (TSS) of the septic tank effluent and consequently lower the biochemical oxygen demand (BOD) of the sub-surface media. Today, there are only a select group of manufacturers who produce this type of septic tank filter.

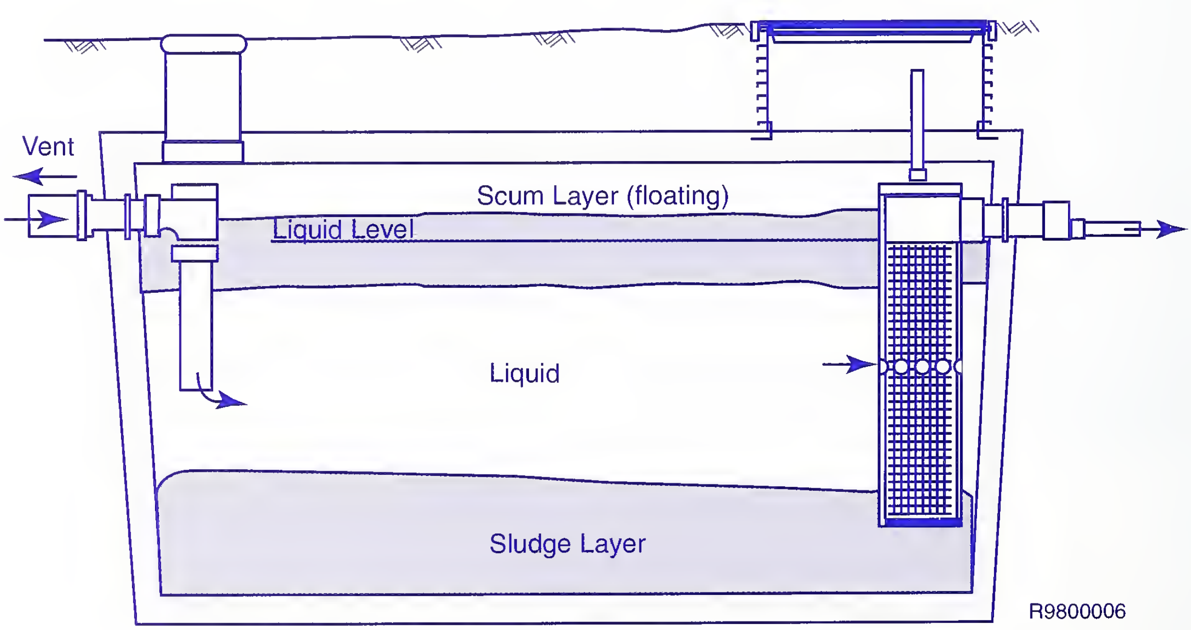


Figure 1—Diagram of a septic tank filter.

Biofilters

Aerobic biologically active filters are collectively called biofilters. Systems utilizing biofilters can be a viable alternative at sites to retrofit or repair failed systems. A single pass aerobic biofilter is designed for efficient and cost-effective treatment of domestic and municipal wastewater.

Waterloo Biofilter™

The biofilter (figure 2) is completely contained in the small transportable insulated box which is generally no larger than the septic tank itself. Because this synthetic filter uses a medium that can be operated independently of external environmental conditions, the system will work well under any soil or disposal conditions. The biofilter is the equivalent of a single pass sand-filter, but the loading rate is 10 times higher in the biofilter.

The wastewater is pumped from a septic tank into the insulated enclosure containing the biofilter. The wastewater is sprayed onto the surface of the biofilter where it is absorbed and treated by colonies of organisms. Air is drawn around the saturated foam media by natural convection or by a small fan. The treated water can then be pump-dosed into a pressurized shallow trench or gravity-fed into a tile bed or leaching field. Presently, the filter is operating in systems that accommodate 7,900 gallons per day.

Peat Biofilter

These systems incorporate a conventional septic tank, a pumping chamber or sump pump with a one-horse-power submersible pump and four polyethylene modules containing biofibrous peat (figure 3). The peat media acts like a condensed drainfield. Biological purification occurs in the media. The effluent percolates through the media and out of the modules by way of perforations in the base. The treated effluent then passes through broken stone placed beneath the system and into the soil.

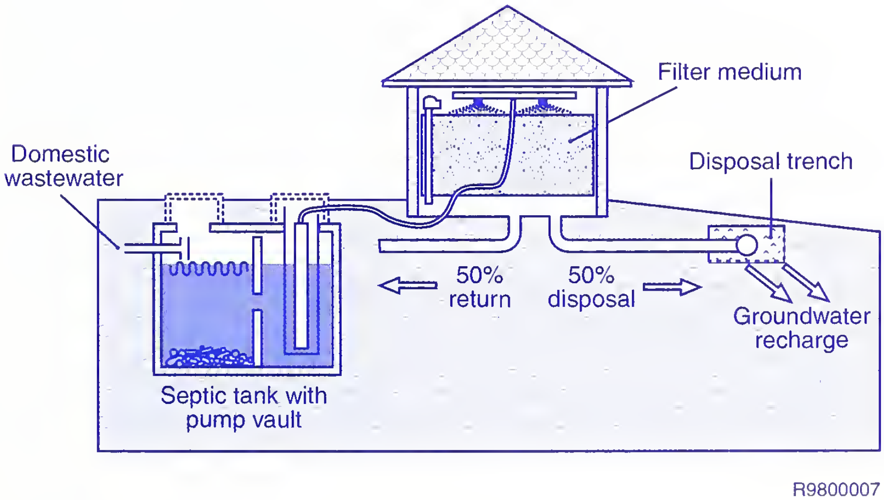


Figure 2—Diagram of the Waterloo Biofilter.

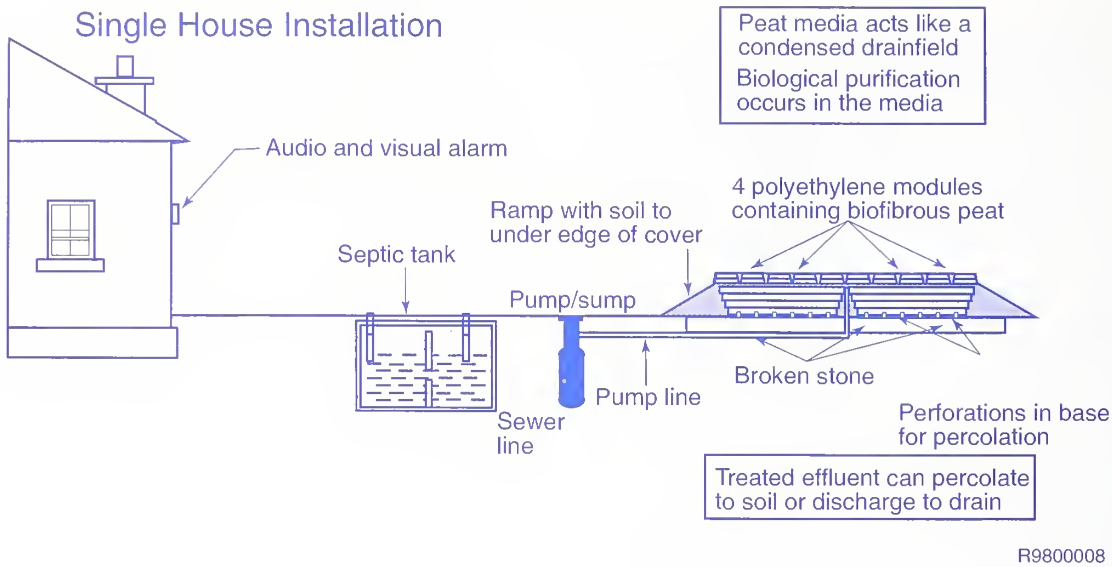


Figure 3—Diagram of a peat biofilter.

The effluent is pressure dosed into the pre-cast modules and equally distributed over the two and one-half feet of peat filter. As more effluent is added to the module, the treated effluent exits holes in the bottom and into an eight-inch deep stone bed. A soil berm surrounds the modules to promote treatment.

Aerobic System

Aerobic systems differ from septic tanks because of the fact that different bacteria are used to treat the wastewater and these bacteria live only in the presence of oxygen. Aerobic systems are more suited to areas with strict land restrictions, however, **effluent must be further treated** in a soil absorption field, sand filter, or be disinfected before discharge. A diagram of an aerobic system is shown in figure 4. The treated effluent is generally of better quality than that of a septic tank alone, thus extending the life of a sub-surface absorption field. The effluent from an aerobic system sometimes, depending on the local rules, can be discharged to surface water after disinfection.

These systems consist of a pump contained within a sealed chamber which is used to force air through the waste water to support the aerobic bacteria. These units are able to liquefy the solids to a greater degree than septic tanks. However, aerobic units are more expensive because of the motor and air pump required and the continual cost of electricity. An aerobic unit works best when the waste is first settled in a septic tank.

It is important that the motor and pump operate properly to assure that oxygen is continuously being added to the wastewater. Aerobic units are very temperature sensitive and treatment effectiveness will fall sharply if temperature variations exist. An aerobic unit works better if the waste water is retained in the unit for an extended period of time. Longer retention times allow the clarifier to separate more solids from the liquid, thereby increasing the effectiveness of the aerobic unit. Abnormal amounts of cleaning agents, grease, or other matter will adversely affect the process and should be avoided.

The unit may be buried, with hatches to mechanical and electrical components. Units installed above ground should be insulated to protect from temperature variations. Heavy-duty pumps and blowers should be used to increase reliability and limit breakdowns.

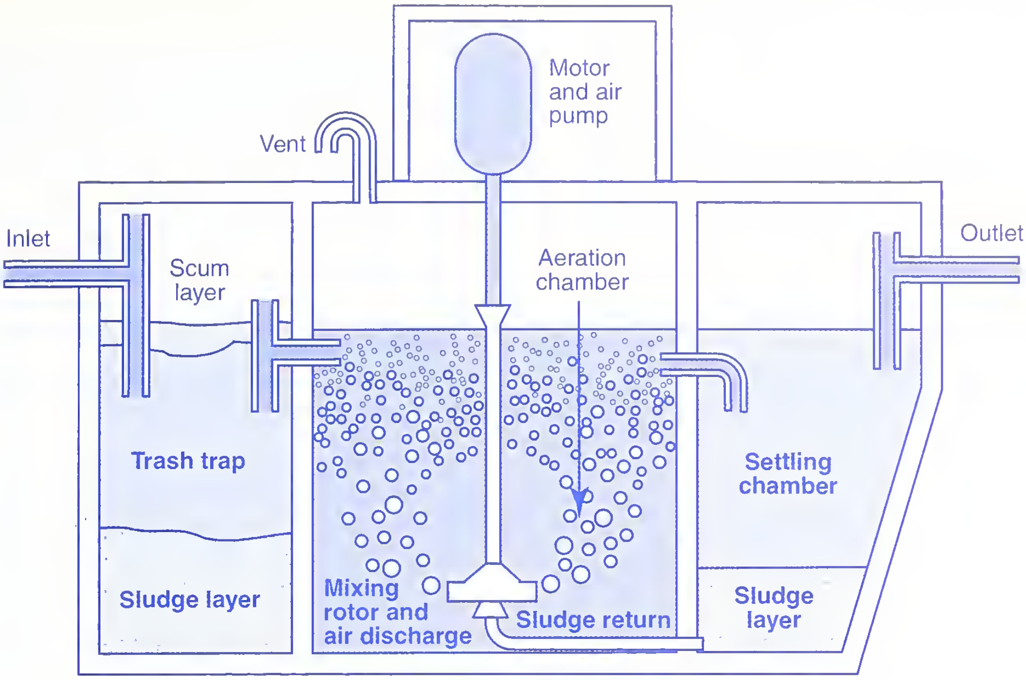


Figure 4—Diagram of an aerobic system.

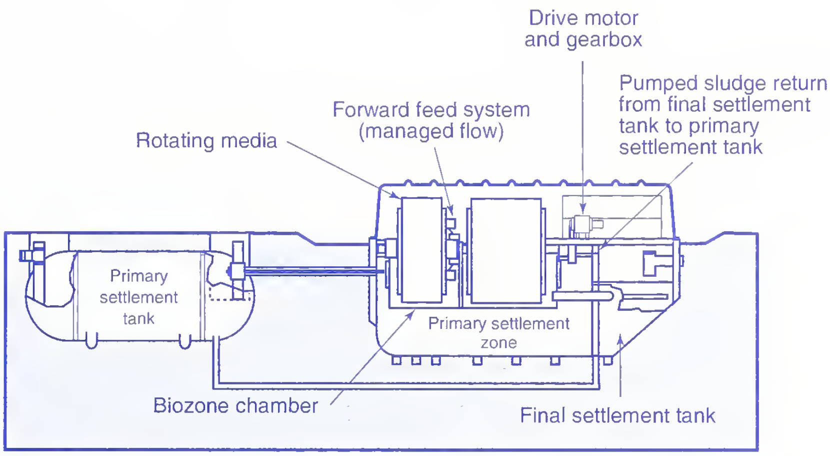


Figure 5—RBC system.

It is advised that a qualified person monitor the unit for the first few weeks. The waste must be occasionally removed from these units and disposed of much in the manner of septic tank wastes. In some cases a conventional septic tank may be retrofitted to accommodate an aerobic system.

Rotating Biological Contactor

A rotating biological contactor (RBC) is a second-stage treatment before the wastewater is transported to whichever disposal method is chosen.

Wastewater is pumped from the secondary compartment of the septic tank to the RBC by a submersible pump. The RBC is partitioned with a series of closely-spaced circular plastic disks (figure 5). The disks are submerged and rotated through the wastewater and then exposed to the oxygen in the atmosphere.

This rotation allows the wastewater and oxygen to alternately be exposed to microorganisms on a biofilm so organic material can be assimilated by

the aerobic bacteria. Microorganisms become attached to the biofilm on the disks which are specially designed to support growth. The disks eventually form a slime layer which treats incoming wastewater. The effluent is then disposed of by the chosen method.

Efficient treatment characteristics provide good incentive for the RBC to used as an alternative technology for on-site treatment of wastewater.

FAST System

FAST is an acronym for Fixed Activated Sludge Treatment. It relies on aerobic bacteria in the inner chamber to digest the incoming wastewater and turn it into a clear, odorless, high-quality effluent. The inner FAST media chamber provides an ideal home for the bacteria colony, so more bacteria remain inside the system instead of being flushed out with the cleaned effluent, even during times of peak usage.

Once installed, the FAST system is virtually maintenance free. The only moving part, the aerating blower, is conveniently placed above ground for easy access in the unlikely event it should ever require service. Only an occasional septic tank pumpout is necessary.

The FAST unit could be installed in an existing septic tank by cutting the correct size opening in the top of a two-compartment concrete tank. Normal installation consists of installing the FAST unit in a new septic tank and replacing the existing tank with the new one (figure 6).

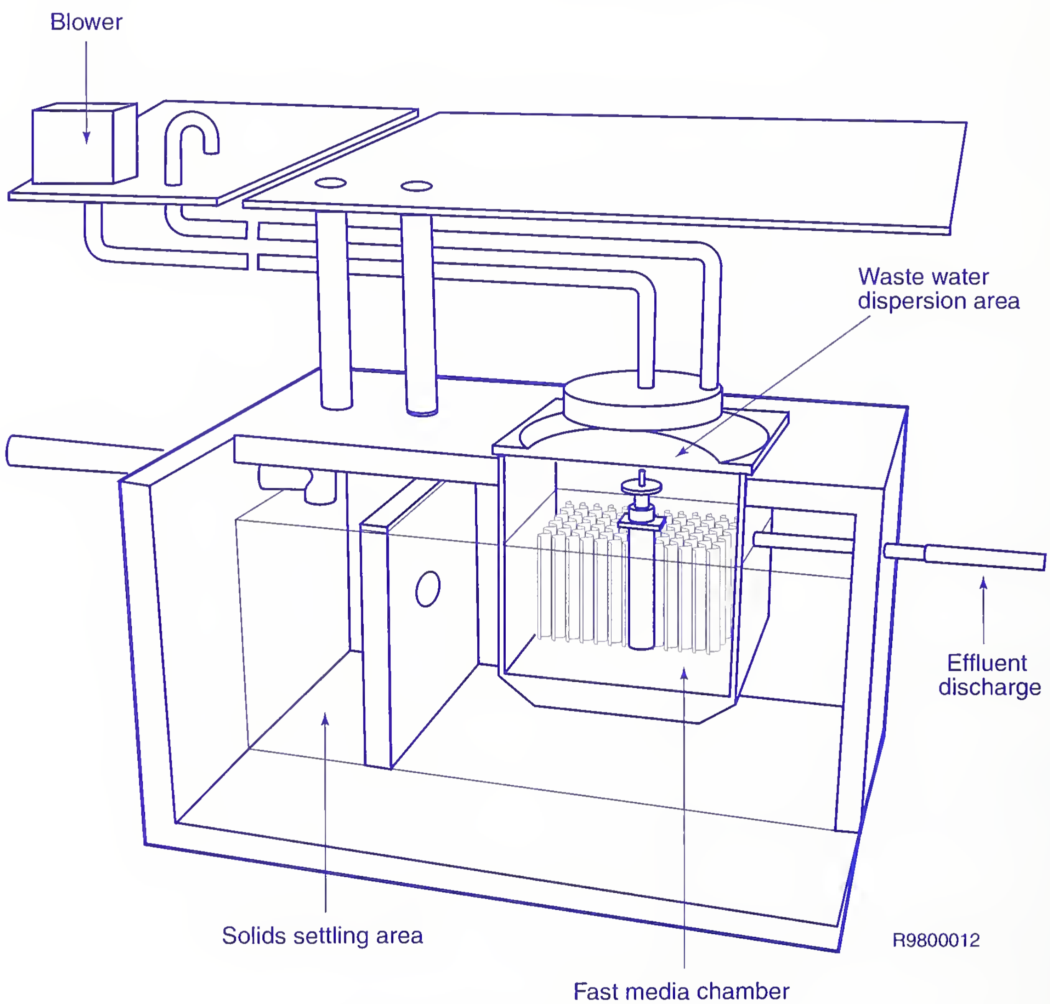


Figure 6—FAST system diagram.

Singulair Bio-Kinetic Treatment System

The Singulair System manufacturered by Norweco, quietly, efficiently and automatically treats all wastewater in just twenty-four hours (figure 7). The system consistently reduces all domestic wastewater to a clear, odorless liquid. The process involves a natural, biological breakdown of the organic matter in the wastewater. A stabilized effluent is discharged from the system and safely returned to the environment.

All wastewater enters the pretreatment chamber where anaerobic bacterial action and the effects of gravity combine to precondition the waste before it is introduced to the aeration chamber. Once in the aeration chamber, the aerobic bacteria utilize the organic matter in the wastewater to biologically convert the waste into stable substances. This is accomplished by holding the wastewater for twenty-four hours while introducing controlled amounts of oxygen. After aeration, the liquids flow into the clarification chamber where the fine particles settle toward the bottom, they are guided into the center of the hopper and returned to the aeration chamber. Only clarified liquids pass through the final treatment stage. Clarified liquids enter the Bio-Kinetic system through the filter media and are held in the baffled perimeter settling zone. Liquids exit the perimeter settling zone through two design flow equalization ports.

Whitewater Aerobic Treatment Unit

The Whitewater Aerobic Treatment Unit (ATU) works by using the bacteria nature provides. As a result of air being pumped into the system, the bacteria grow in much greater numbers than would

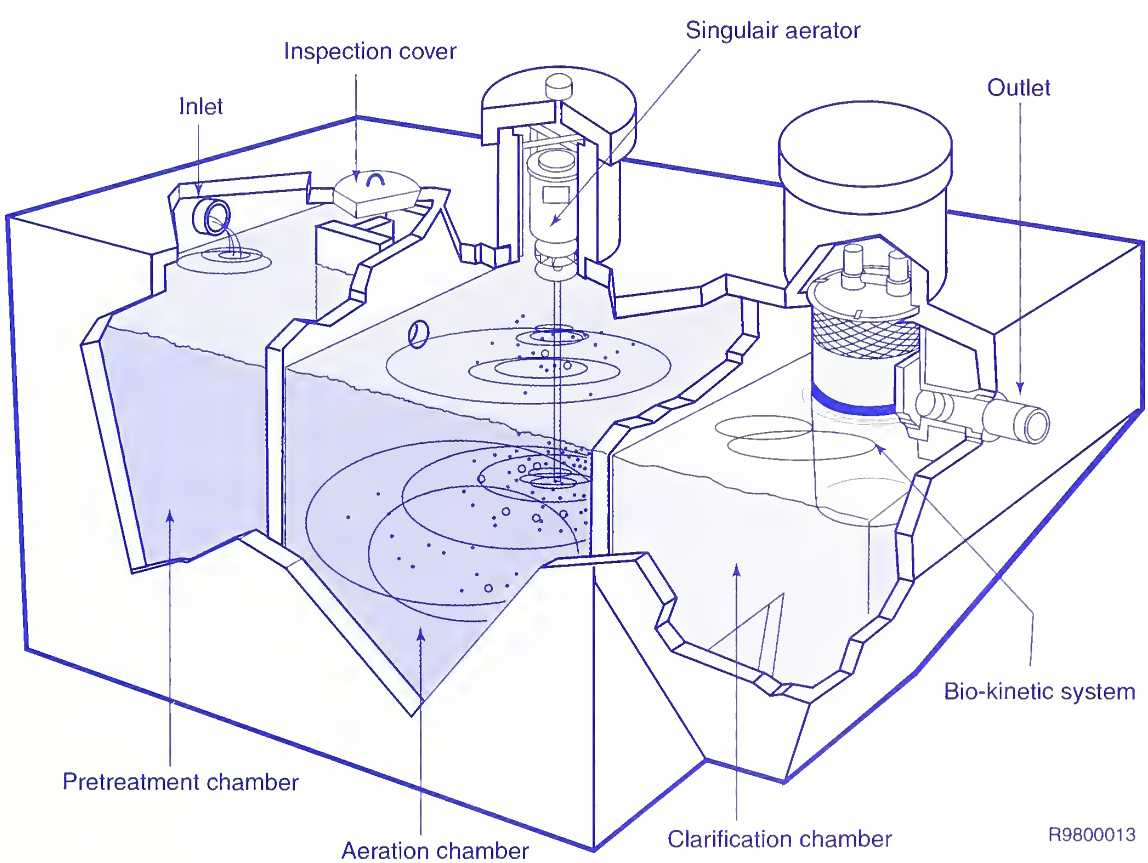


Figure 7—Norweco Singulair Bio-Kinetic System.

occur naturally. This "overpopulation' of bacteria speeds the process of breaking down the sewage, making it safe for release into the environment.

The process occurs entirely within the self-contained Whitewater ATU which is comprised of an outer mixing tank and a cone-shaped settling chamber (figure 8). Raw, unsettled domestic wastewater enters directly into the mixing tank where mixing occurs through an air distribution system. Solids remain in suspension with a general flow up the outer plant wall and down the outside of the settling chamber.

The mixed liquid then enters the settling chamber from the bottom. The settling chamber maintains a quiet condition which allows solids to settle down and re-enter the mixing chamber for more processing. The liquid is hydraulically displaced upward and is discharged as clear, odorless treated water which meets or exceeds state water quality standards.

Nibbler Jr. Wastewater Pretreatment System

The Nibbler Jr. manufacturered by Northwest Cascade-Stuth (NCS) is a pretreatment system designed to buffer a wide range of primary effluents from light commercial to high strength residential waste (figure 9). The Nibbler Jr., does this through a patented process that utilizes air lift technology. Oxygen is introduced to the wastewater and allows the aerated flow to be exposed to both submerged and trickle media. This combination provides an optimum environment for maximum treatment. This technology also lifts the effluent to a discharge point above the liquid level in the tank which regulates the flow without the assistance of electrical time control panels. The only mechanical component of this system is the blower which introduces air to the wastewater.

Bioclere Wastewater Treatment System

he Bioclere wastewater treatment system by AWT Environmental, Inc. uses a fixed-film process to treat septic tank effluent to reduce organic and

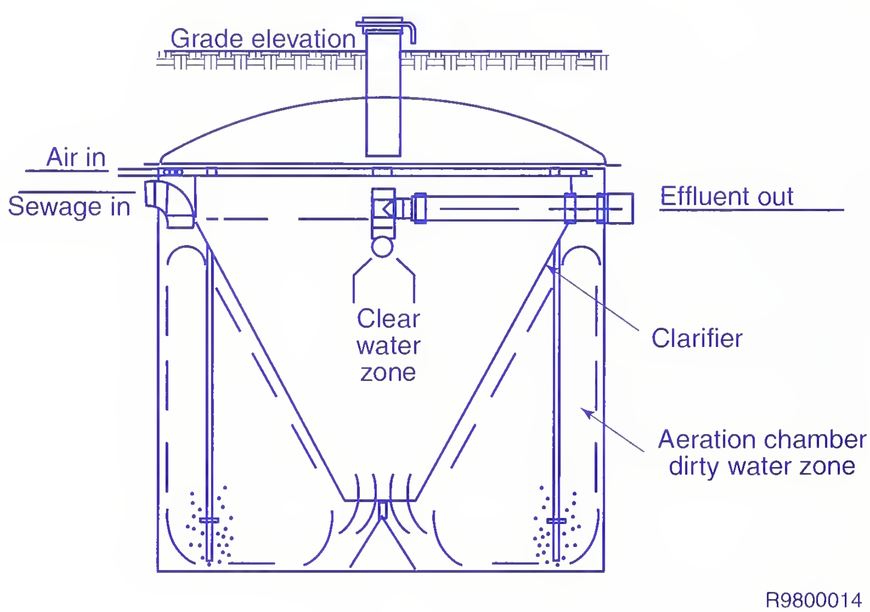


Figure 8—Whitewater ATU schematic.

nutrient constituents (figure 10). Septic tank effluent flows by gravity to a 500 gallon baffled clarifier chamber in the Bioclere unit. The effluent is mixed with the treated water in the chamber, and the dosing pump intermittently pumps the effluent onto a distribution plate that irrigates the filter media. The dosing pump normally operates at a 5-minute-on and 2-minute-off cycle. The effluent is treated as it trickles through the media and over the biological film that grows on the media surface. The treated effluent returns to the clarifier chamber and overflows to the pump chamber outside the Bioclere unit. Sludge that has accumulated in the bottom of the Bioclere unit is pumped to the septic tank once a day by the sludge pump. The process of returning sludge to the septic tank is designed to reduce total nitrogen from wastewater.

BioCycle Wastewater Treatment System

BioCycle is a miniature version of a tertiary municipal sewage treatment plant. It is fully automated; has water, air, loss of power and intrusion alarms; and electricity for operation is about five dollars per month.

All household wastewater - kitchen, bathroom, toilets, showers laundry, etc.- flows into the four section BioCycle system (figure 11). The first section treats the waste anaerobically (without air) and begins the process of breaking down organic wastes. The second section is an aerobic chamber, and here, aerobic bacteria continue and complete the process of digesting wastes. The third clarification chamber removes any solid wastes returning them to the first chamber for re-treatment. From the third chamber the now clear water flows through a disinfection unit and into the fourth chamber from where it is automatically pumped out into a disposal system.

Recirculating Sand Filter

The septic tank effluent flows by gravity to the pump chamber and mixes with the treated effluent that is returned from the sand filter (figure 12). Mixing results in dilution of the septic tank effluent, and the diluted effluent is sprayed on top of the sand filter. Filtration through 24 inches of sand results in further treatment. There are two pumps

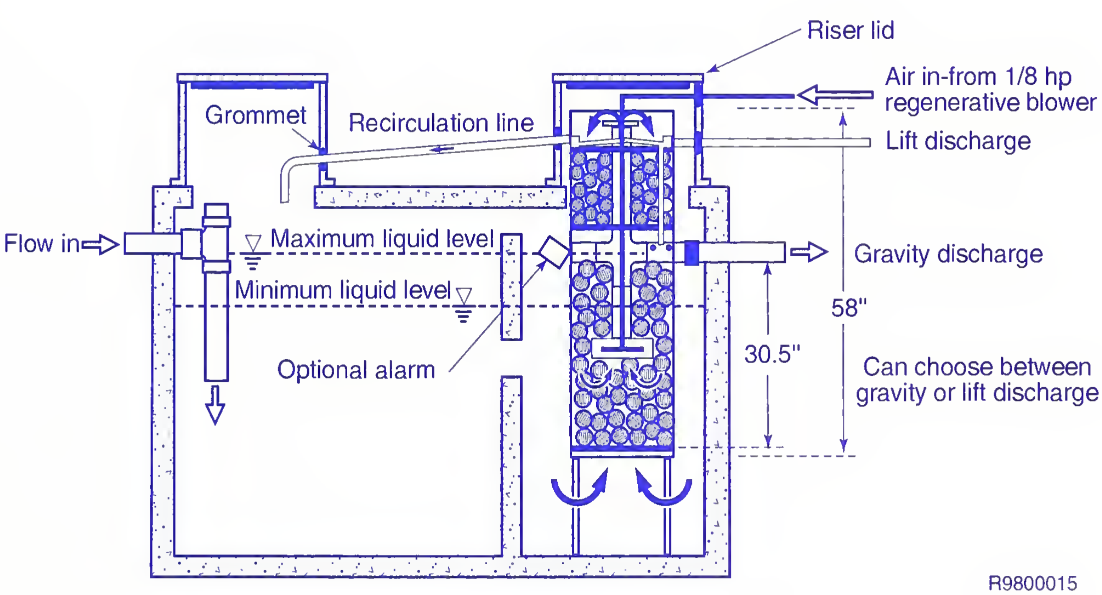


Figure 9—Nibbler Jr. schematic.

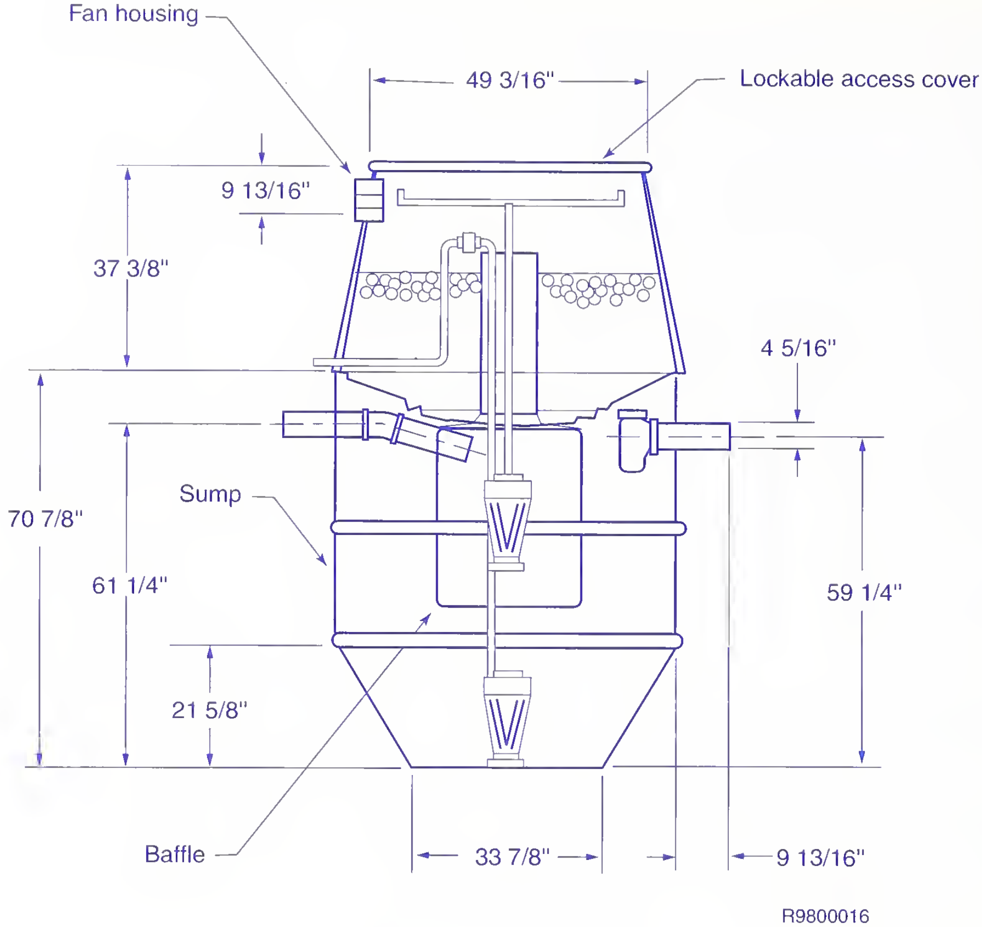


Figure 10—Bioclere schematic.

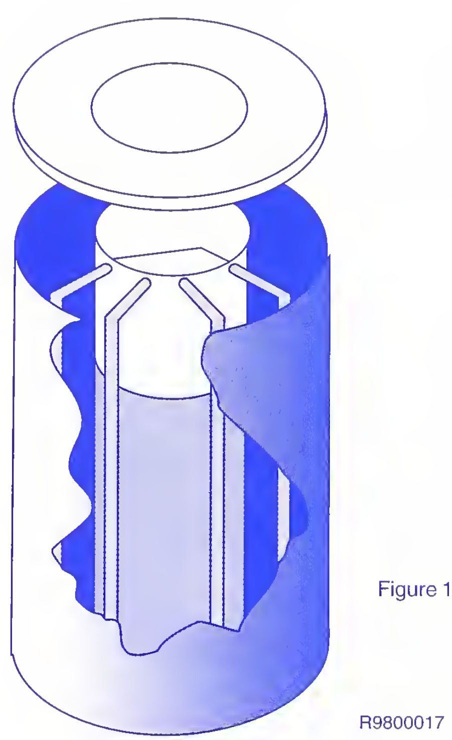


Figure 11—BioCycle schematic.

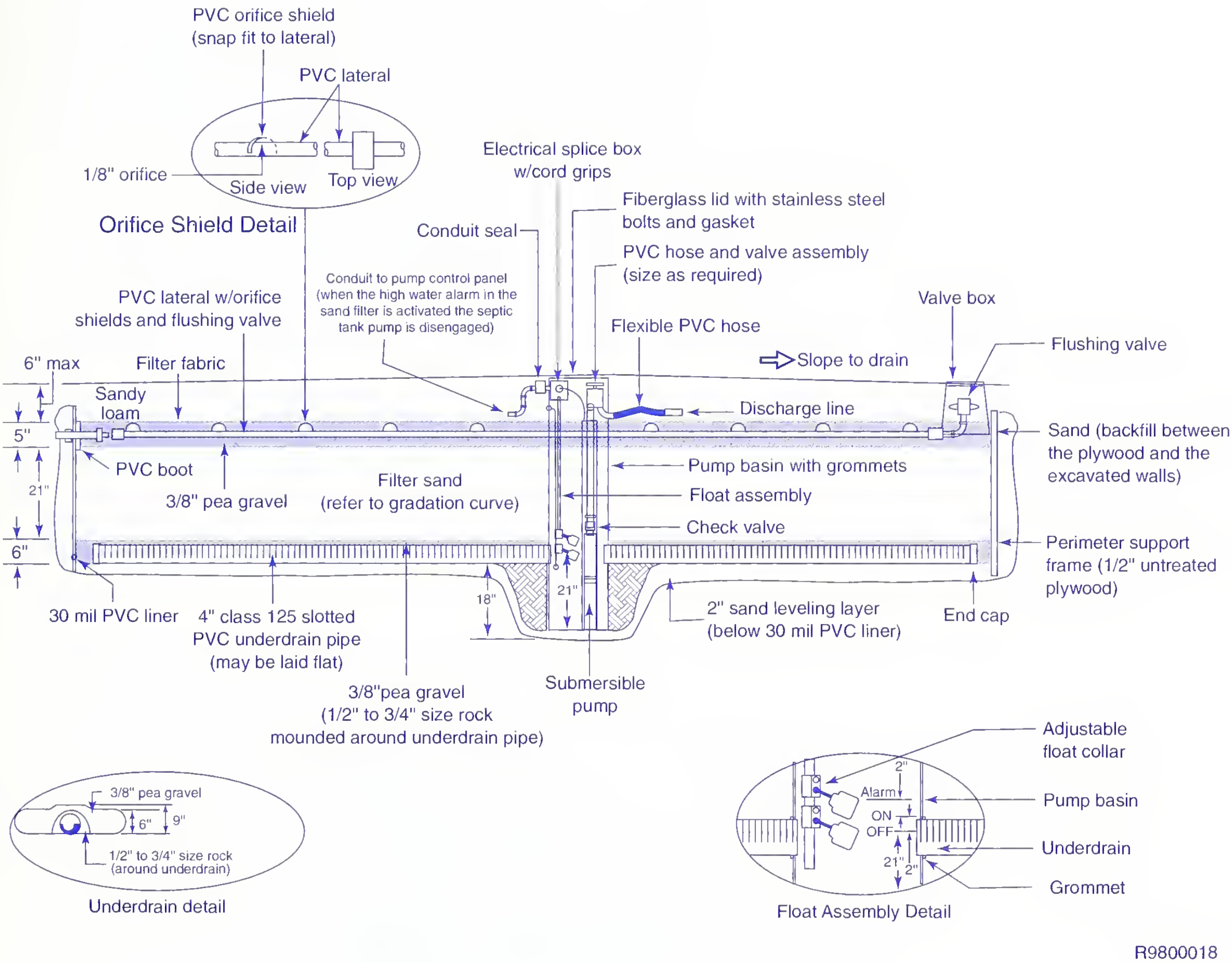


Figure 12—Recirculating sand filter schematic.

in the chamber, one to recirculate wastewater through the sand filter (recirculation pump) and one to dispose of the treated effluent to the disposal field (disposal pump). The recirculation pump is operated by a timer, and the disposal pump is operated by a float system. The timer is set to achieve a recirculation rate of 5:1, while the floats are set to maintain at least 500 gallons of water in the pump chamber.

Recirculating Trickling Filter

The recirculating trickling filter (RTF) system is installed over the inlet end of the septic tank and is an integral part of the tank (figure 13). Septic tank effluent is recirculated through the filter on a continuous basis, and the effluent is treated in the septic tank itself. This system is designed to lower total nitrogen content by a nitrification and denitrification process. The monitoring results indicate that the effluent quality (primarily BOD5, T-N and T-P) from the tank with the RTF is significantly better than the effluent from septic tanks without the RTF.

Septic tanks can be designed to accommodate the RTF over the tank at the inlet end and two pumps in the effluent screen vault. A one-third horsepower pump is used for recirculating septic effluent through the RTF, and a one-half horsepower pump is used to dose the sand-lined bed. Both pumps are operated using a float and timer system. The disposal pump doses effluent every ninety minutes, provided there is an adequate quantity of water in the tank. The disposal pump runs for less than fifteen minutes per day, while the recirculation pump in its current setting runs almost continuously.

Alternating Intermittent Recirculating Reactor System

The primary section of the alternating intermittent recirculating reactor (AIRR) consists of a spetic tank and a dosing tank, from which the effluent is pumped (figure 14). The secondary section's processed fluid is directed by an underdrain to the recirculation tank and then pumped through the sprinklers over both the secondary and tertiary sections. The treated fluid falling on the tertiary

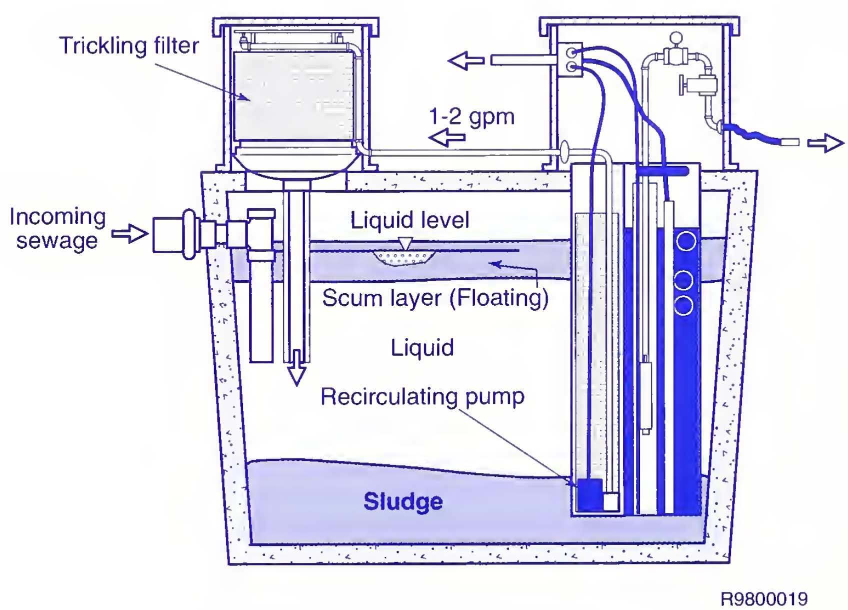


Figure 13—Recirculating trickling filter schematic.

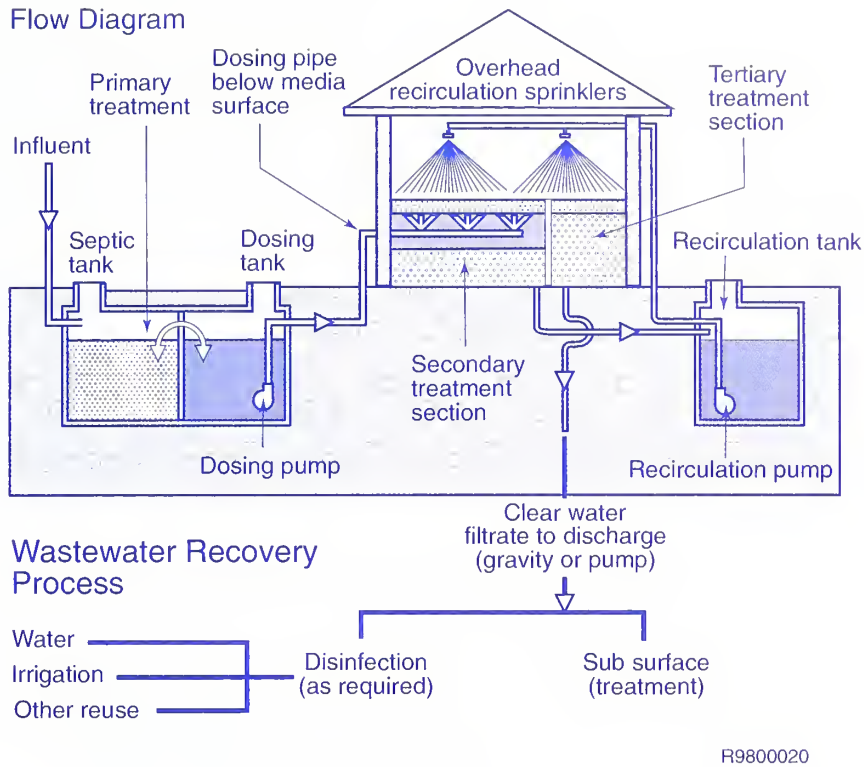


Figure 14—AIRR system schematic.

sections must go to discharge. Some of the advantages are no chemicals required, low construction cost (local materials and labor), low electrical operating cost, and low maintenance. Construction of facilities can be above ground, below ground or part above and below ground. Some AIRR systems have buildings, patios, parking lots and basketball courts on top. Additional facilities (modules) can be added as volume increases.

DISPOSAL OPTIONS

Under proper conditions, wastewater may be safely disposed of onto the land, into surface waters requiring a National Pollution Discharge Elimination System Permit (NPDES), or evaporated into the atmosphere by a variety of methods. The most commonly used methods for disposal of wastewater from campgrounds and administrative sites can be divided into three groups: (1) sub-surface soil absorption systems, (2) evaporation or spray systems, and (3) treatment systems that discharge to surface waters.

Primary Treatment Unit with Alternating Trenches

Alternating trenches are used in conjunction with the primary treatment unit and a valve box. The concept of this system is to allow one set of trenches to work while the other rests idle. This design can extend the life of the system and provides for a back-up if one set of trenches should fail (figure 15).

The valve is manually activated and directs effluent into the working trench. The trenches are alternated annually and are switched at the

beginning of the summer. In the event that system repairs are needed, a new valve and field can be added while repairs take place.

Shallow Trench Low-Pressure Pipe Distribution

These systems consist of a primary treatment system; such as, a septic tank, a pumping tank, and a small diameter pressure distribution network with several clean-out ports. Because the system uses a smaller diameter pipe than convention sub-surface systems, the system can be located at a more shallow depth.

The effluent travels under pressure through small holes in the pipe and saturates the entire trench network. These systems are commonly used in areas exhibiting high groundwater, shallow soils or steep slopes.

These systems are desired because they prevent certain areas of the field from being continuously loaded. These areas are not allowed to dry out between dosings, which can lead to a buildup of organisms and solids which restricts the flow of effluent through the soil. This problem, known as soil clogging, is detrimental to the soil field, as less water can be treated. Low-pressure distribution assures that the effluent is spread over the entire area of the field and that all parts of the field are allowed to dry between dosings, greatly reducing the chance of clogging (figure 16).

Low-pressure distribution networks are desired for soil absorption systems. The added cost of the pump will be offset by the increased life of the system which results from the lack of soil clogging. The distribution pipes must be placed in gravel to prevent the pressured effluent from washing away

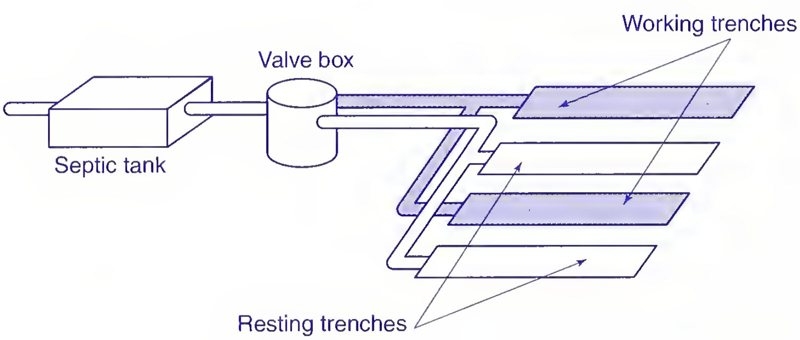


Figure 15—Diagram of a septic tank with alternating trenches.

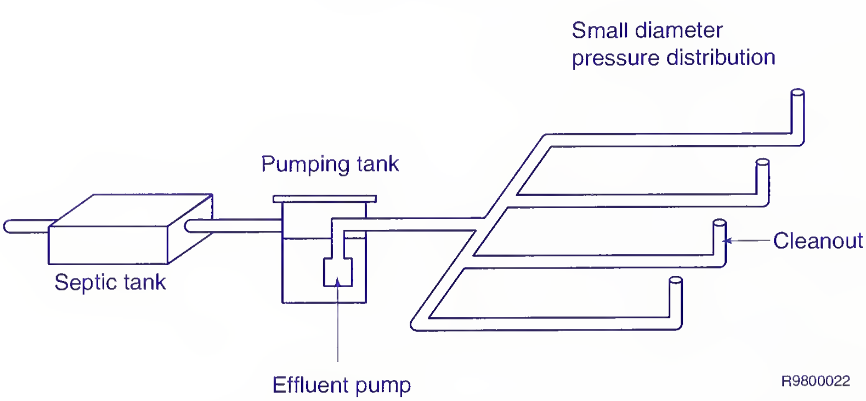


Figure 16—Diagram of a shallow trench low-pressure pipe distribution system.

soil from around the pipes. The distribution lines should be cleaned annually by professional maintenance personnel.

Contour Disposal Field

Contour disposal systems are sub-surface absorption fields that are laid parallel to the natural contour of the ground surface. By placing only one distribution trench along the contour of the land, the effluent stream is spread over the full width of the site and is undetectable.

Contour disposal systems incorporate either (1) a trench that is dug and then filled to ground level (figure 17a), (2) a shallow trench that includes a layer of sand to contain and treat by filtration any overflow that would otherwise pond on the surface (figure 17b) or (3) a configuration that is built up above the ground level, much like a standard EPA-style mound system, but laid out along a contour (figure 17c).

Trenches longer than 150 feet will require pressure distribution by pump or siphon. The systems should not be installed on a flat area but instead be on a five to 30 degree slope.

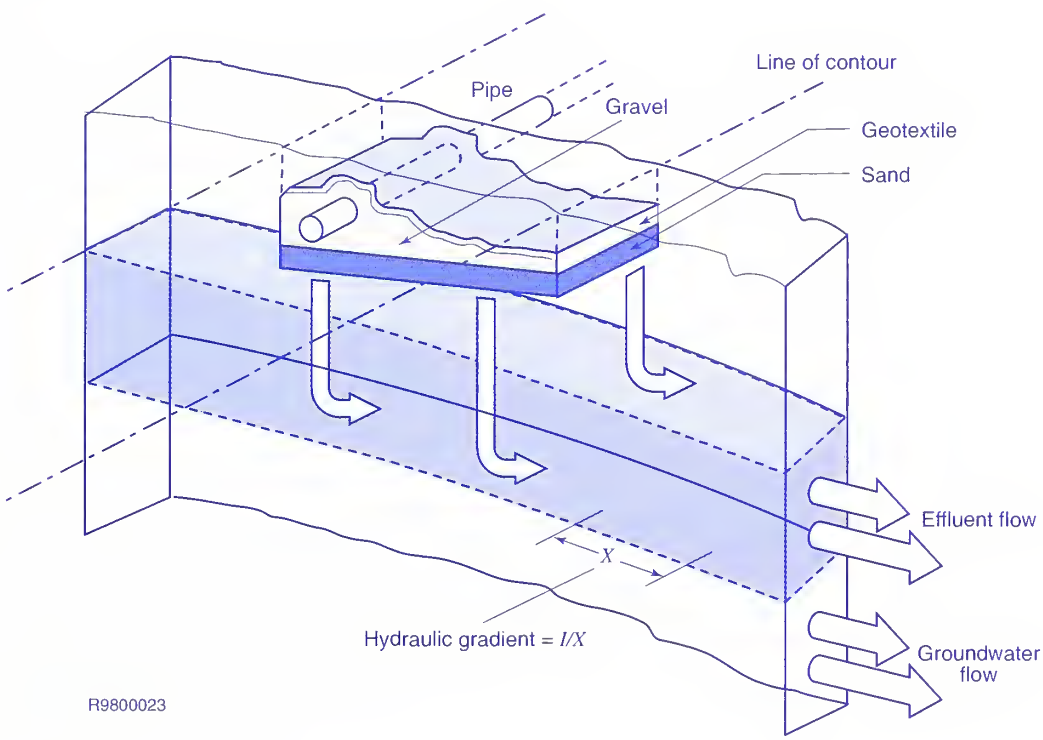


Figure 17a—Diagram of a contour disposal field. (Type 1)

Type 3-Section

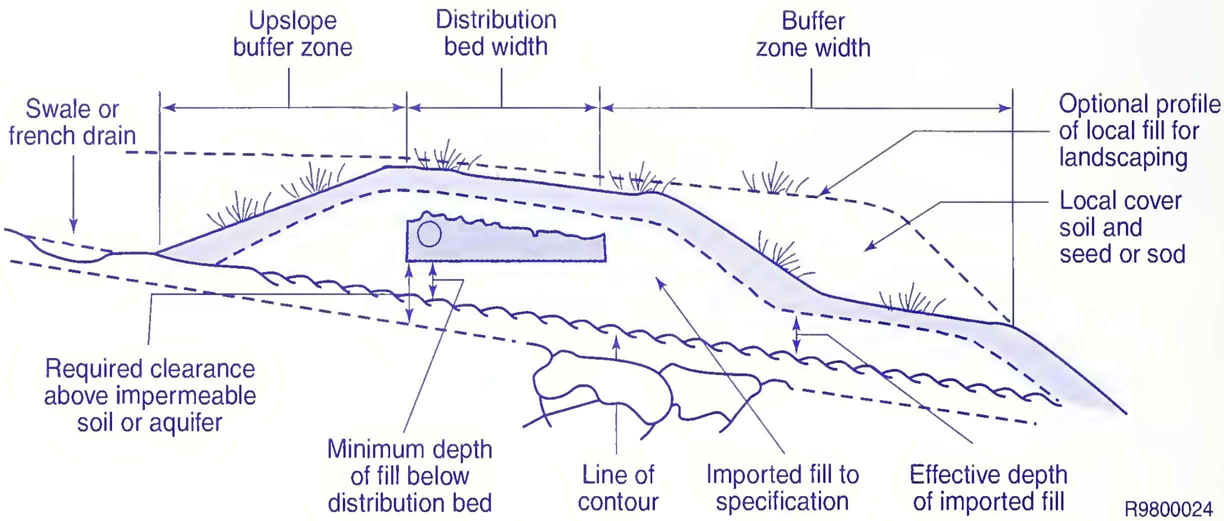


Figure 17b—Imported fill disposal field (Type 2)

Type 3-Section

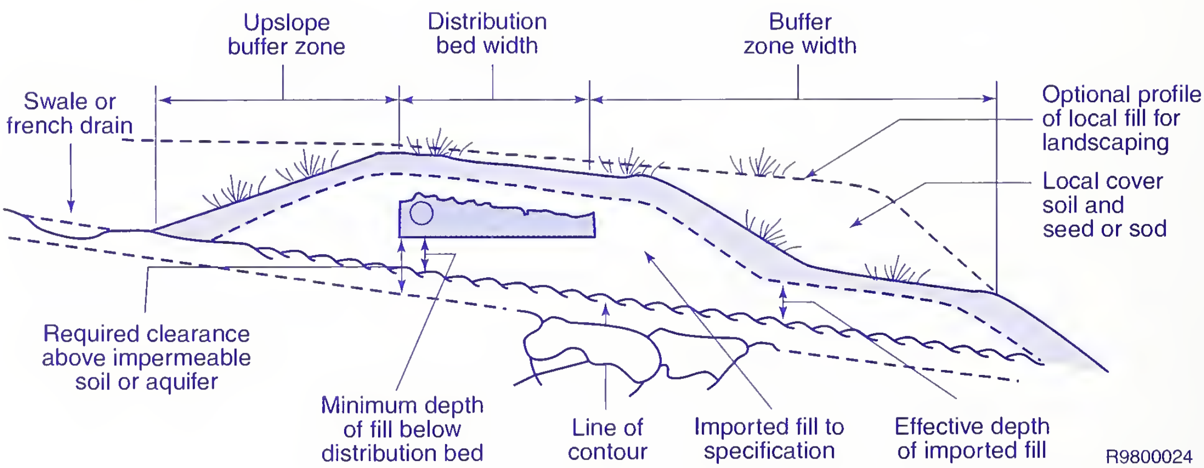


Figure 17c—Imported fill disposal field (Type 3)

Gravel-less Trench and Leaching Chambers

These systems differ from conventional gravel-filled drainfields in that no gravel is used in the drainfield's soil absorption trench (figure 18). The systems use either 1) a special synthetic filter fabric-wrapped large-diameter pipe, 2) a molded leaching chamber or, 3) a gravel substitute such as rubber, sand, fiber membrane, plastic, glass, slag or chipped shale.

These systems accept the partially treated effluent into the sub-surface absorption field. Chamber systems use a buried cement or plastic support structure to maintain an underground void allowing for the storage and subsurface aeration within the drainage trenches. If the nongravel materials are installed surrounding the leachfield distribution pipes, they should be set in an 18 to 24 inch deep trench.

These systems work as well if not better than conventional gravel systems because they allow more total soil contact area for permeability and less soil compacting. Most of the gravel-less materials are lighter than gravel and do not require the use of heavy equipment and therefore can be installed by hand.

Pressure Dosed Distribution

The pressure dosed distribution system consists of a primary treatment system, a pump or siphon, a pressure manifold and a gravity absorption field (figure 19). The dosing technique can prolong the life of the system by flooding a larger area and by forcing the exchange of air in the soil.

The pump or siphon doses the pressure manifold which in turn disperses the effluent evenly to each trench. The pressure manifold can include valves or plugs that permit more control over trench loading.

These systems are common for larger flows, but more frequent inspection is recommended.

Artificially Drained System

In some areas with high water tables, that would limit the construction of conventional trenches or beds, artificially drained systems may be used (figure 20). These systems are used to lower the water table or divert surface water runoff and allow the disposal system to have enough time for sufficient treatment of the effluent before it reaches groundwater.

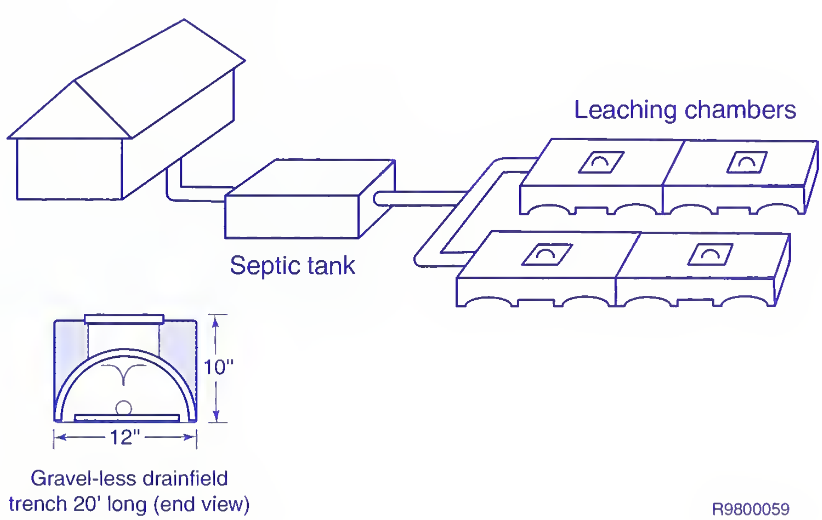


Figure 18—Diagram of a gravel-less trench and leaching chamber system.

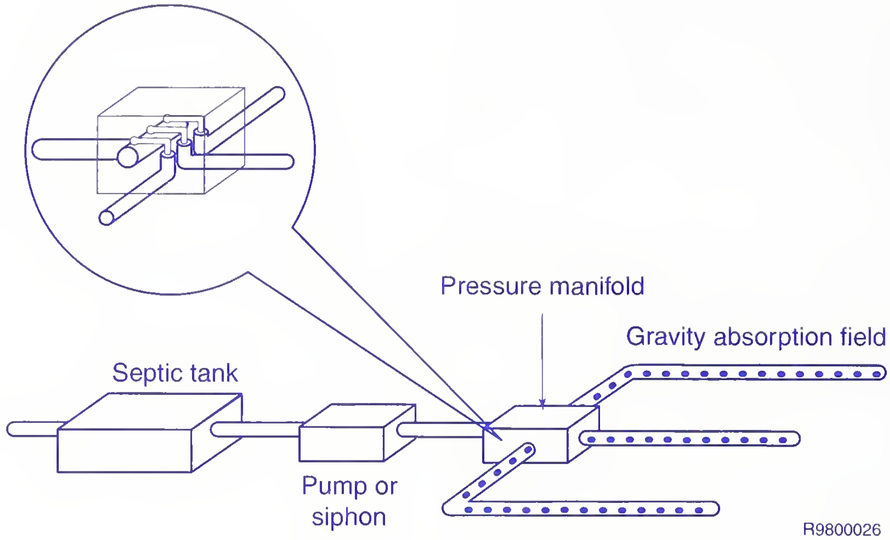


Figure 19—Diagram of a pressure dosed distribution system.

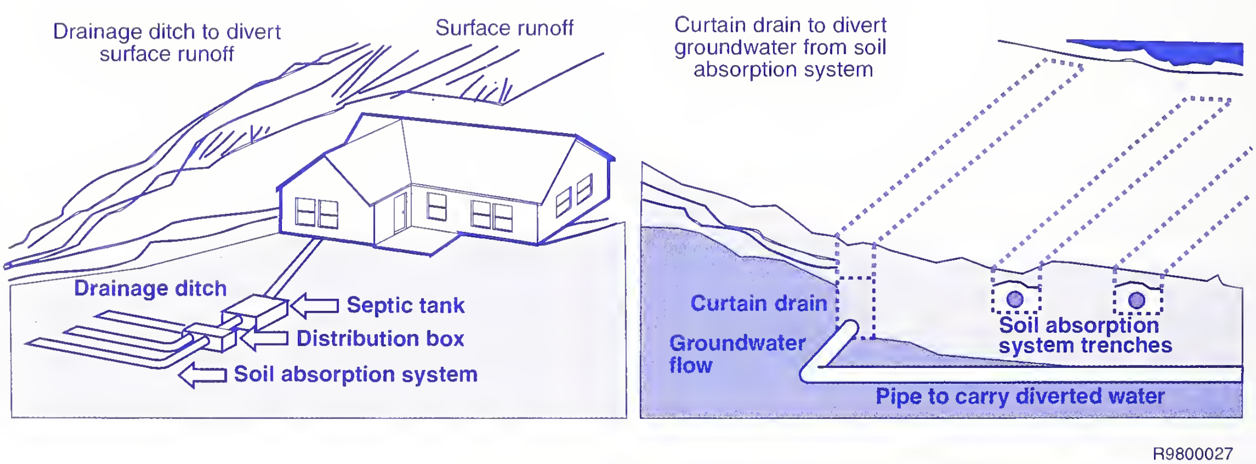


Figure 20—Diagram of an artificially drained system.

Curtain drains are trenches in which perforated drainage pipe is placed. These are placed at the upslope perimeter of the soil absorption system to intercept the groundwater before it moves into the absorption area. Underdrains are similar, but are used where water is 4 to 5 feet below the surface; several drains may be necessary. Vertical drains are used if the restrictive layer that creates the high water table is thin and overlies permeable soil. These are trenches made through the restrictive layer into the permeable soil which are then filled with porous material. Thus, the water is able to drain into the underlying soil.

If surface runoff is a problem, a diversion ditch can be used to divert this runoff from the site. It is simply a trench which catches the water and carries it away before it can reach the absorption field. The trench will likely be covered with gravel or have grass planted in it to prevent erosion. A terrace or other raised mound would also work to divert the water. A diversion ditch allows a conventional system to be used in an area where surface runoff would otherwise flood the area and make it unusable. This method is quite inexpensive and does not require any costs after construction.

Successful design of artificially drained systems depends on a correct diagnosis of the drainage problem. The groundwater source and flow must be determined to select the proper method of drainage, or the path of runoff must be determined. Soils that are saturated for long periods are not practical to drain, and other systems should be found. Artificial drainage is made to eliminate shallow, lateral flow problems with groundwater, or places where runoff is causing problems. **They will not work in areas where the groundwater will flow in faster than it can be pumped out, nor will they work in areas where water remains ponded.**

Oversized Distribution Area

In soils that may be prone to failure by clogging, such as in fine soil, the size of the absorption field may be increased over that which would be normally used. This allows extra area for infiltration, and will help prevent ponding of effluent in certain areas of the field. This ponding can lead to a buildup of organisms and solids which will decrease the absorption ability of the soil. Oversized systems are used to allow the effluent to be spread over a greater area, thus limiting the possibility of clogging and allowing for short periods of higher-than-average flow rates

The degree to which the area is oversized depends on the soil conditions, and the probability that the soil will clog. The extra cost of the added area and pipes will be offset by the increased life of the system.

Electroosmosis System

Electroosmosis is a technique using a direct current which is passed through the soil, drawing the liquid to the positive end. The water that collects can be pumped from the ground. This technique was developed for use in soils with slow permeability. The system is used with a typical soil absorption system which must be installed and operated properly. The electroosmosis system merely draws the moisture through the soil more quickly, especially in areas where the soil passes water slowly.

The design is patented, and therefore design and construction of the system must be done by licensed personnel. The system requires very little maintenance, except during pretreatment.

Septic Tank Effluent Pumping System

In the mid-1970's engineers introduced the concept of a vault that fits directly into the interceptor tank and houses the pump (figure 21). The system is known as septic tank effluent pumping (STEP). Effluent enters the vault through 1 3/8 inch holes located between the scum and sludge layers of the septic tank. Effluent entering the vault from this clear layer is relatively free of solids. In the mid-1980's a means was introduced to screen the effluent before pumping that made it feasible for the first time to use turbine pumps in an effluent sewer.

As it enters the pump vault, effluent surrounds a one-eighth-inch mesh screen cylinder where particles larger than one-eighth-inch are trapped. Twelve square feet of screen surface area effectively lowers the concentration of suspended solids in the effluent by a factor of 2.5 before it is discharged into the collection line. Biological growths on the surface of the screens may also enhance treatment; in the past 12 years, pressure sewer systems have consistently reported that screened septic tank effluent is significantly lower in biochemical oxygen demand (BOD) and suspended solids (SS) than is unscreened effluent.

Operator familiarity with pump characteristics, power requirements and trouble-shooting procedures is essential, especially when a system's pumps vary in make, size and style. Turbine effluent pump's high head capacity often makes it feasible for a single one-half horsepower model to serve every location in the system. The lower power requirement of the smaller motor also means that expensive electrical renovations are unnecessary, making the pump particularly suitable for low-cost housing. STEP systems can collect effluent from several separate areas and pump it to a central treatment/disposal area.

Other Disposal Systems

Figures 22, 23, 24, 25, and 26 illustrate how some of the disposal systems look in plan view; also, advantages and disadvantages for each system shown are listed.

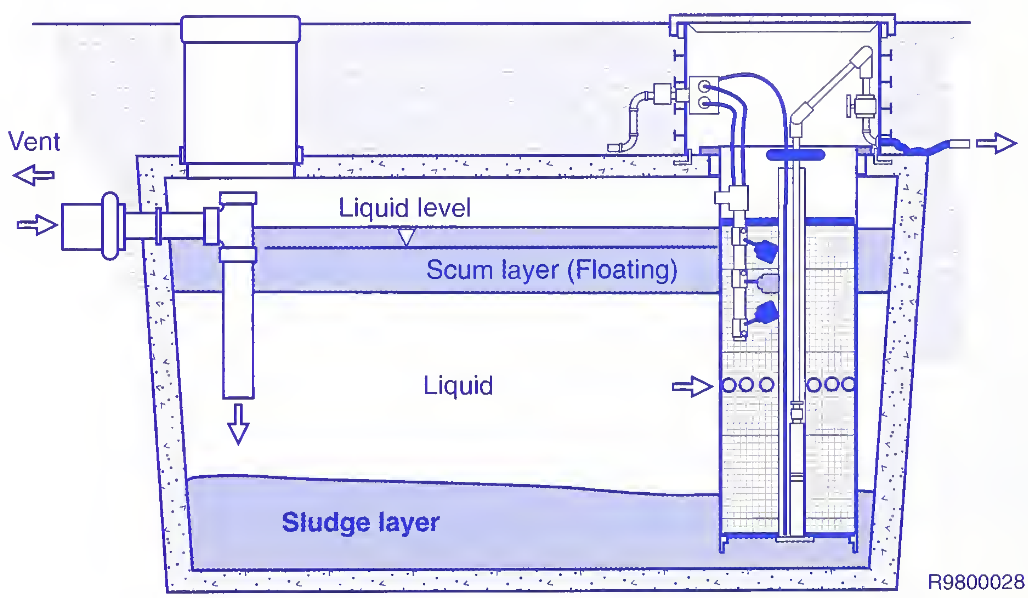


Figure 21—STEP system.

Gravity/Gravel Bed Disposal System

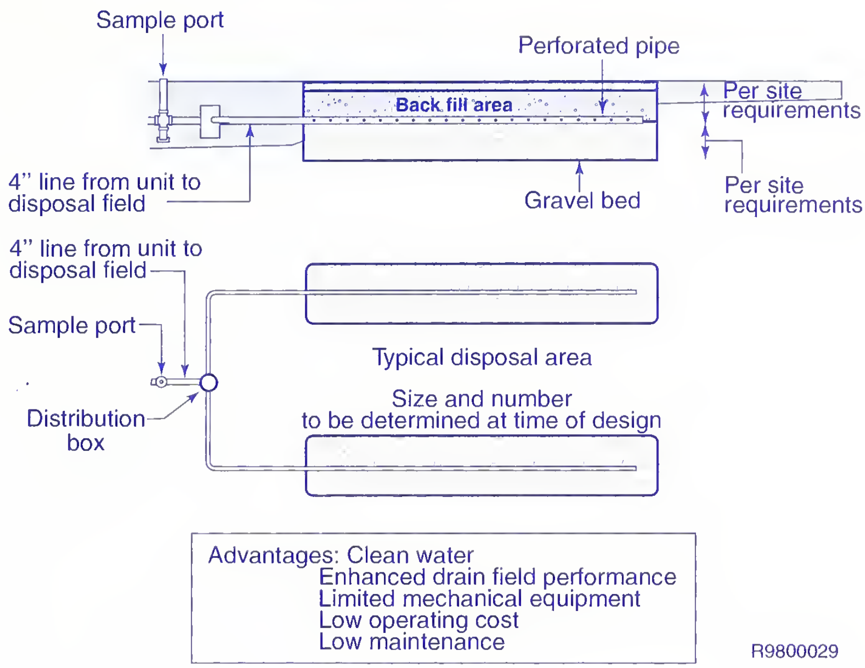


Figure 22—Gravity/gravel bed disposal system.

Artificial Leaching Chamber

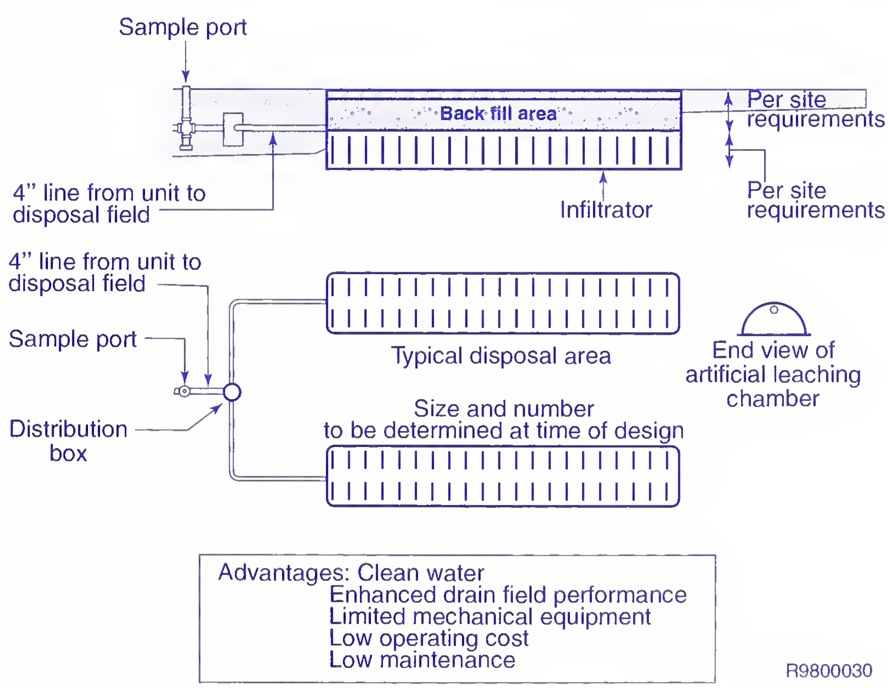
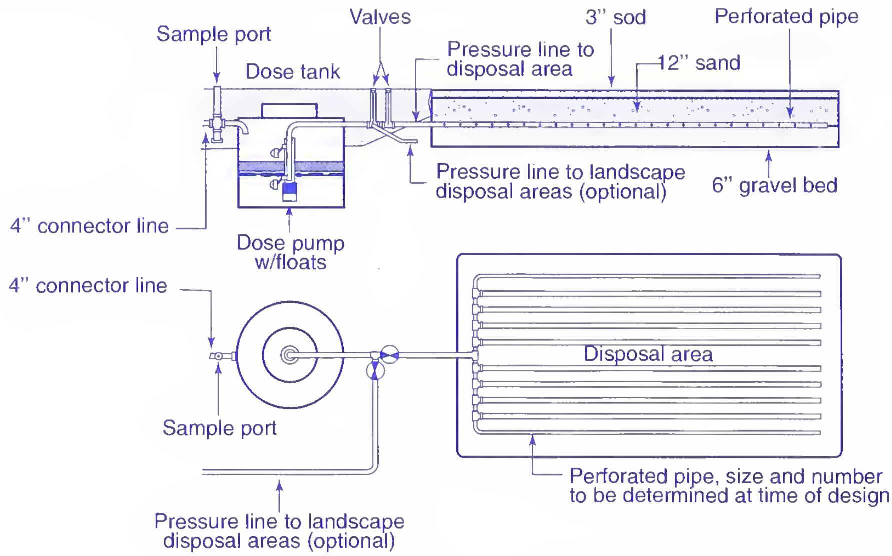


Figure 23—Artificial leaching chamber.

Low Pressure Piping System



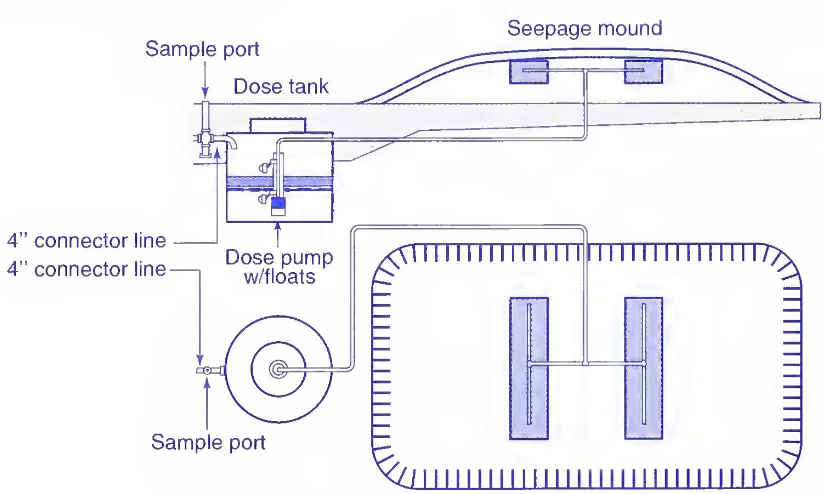
Advantages: Effective in poor percolation areas
Enhanced drain field performance
Effective in high water table areas
Versatility: i.e... landscape irrigation
No filter required
Low operating cost

Disadvantages: Installation cost

R9800031

Figure 24—Low pressure piping system.

Seepage Mound Disposal Method



Advantages: Effective in low perculation soils
Effective in high water table areas
Low operating cost

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Figure 25. Seepage mound disposal method. (Described in the previous publication)

Sprinkler Disposal System

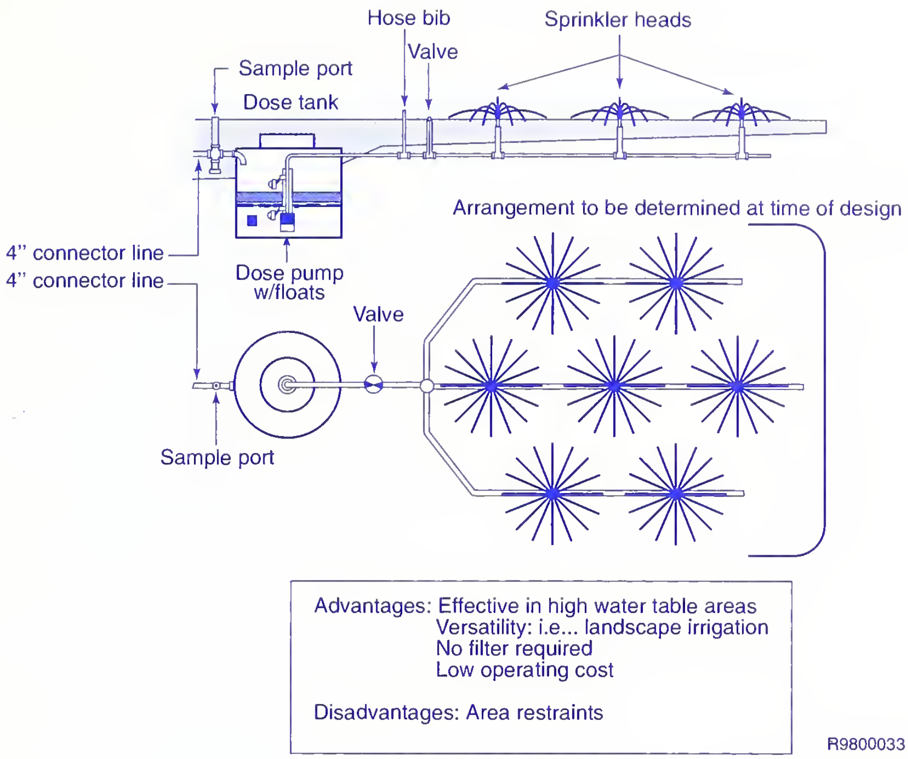


Figure 26—Sprinkler disposal system. (Described in the previous publication)

Emitter Systems

Another disposal method that has been successfully tested in the southern U.S. is the emitter system (drip irrigation). For this method, the effluent is filtered, then pumped into a grid of plastic irrigation pipes with built-in drip emitters every two feet (figure 27). The irrigation pipe is installed six inches below grade with a vibrating plow attachment on a small tractor—no digging is needed (figure 28). In situations where steeply sloping ground makes a standard trench impractical, drip irrigation lines can be successfully placed along the contours of the slope.

The system depicted above is an emitter disposal system which was attached to an existing septic tank. The property line to the Northeast did not allow a standard leach field. A pump chamber and controls were added and an emitter system was installed approximately six inches under ground behind the house.

SUMMARY AND CONCLUSIONS

Large segments of the United States and the world are facing a critical water supply shortage because of population and economic growth, persistent drought conditions and a lack of adequate planning for future water needs.

Fortunately, solutions are available which can help alleviate these problems by reducing water consumption in an environmentally acceptable manner. Typical of the devices that can help are low-flow toilets, low-flow shower heads, and faucet flow restrictors. The Energy Policy Act of 1992, Public Law 102-486, requires the use of energy conserving devices, for Federal agencies, whenever possible. Further reductions can be achieved by on-site wastewater treatment and recycling systems that permit reuse of greywater for landscape irrigation and toilet flushing.

Advantages: Effective in poor percolation areas
Effective in high water table areas
Flexibility
Gravelless trenches
Utilize entire absorption field
Land irrigation

Disadvantages: Installation cost
Higher maintenance
Higher operating cost
Emitter failure
Filter system

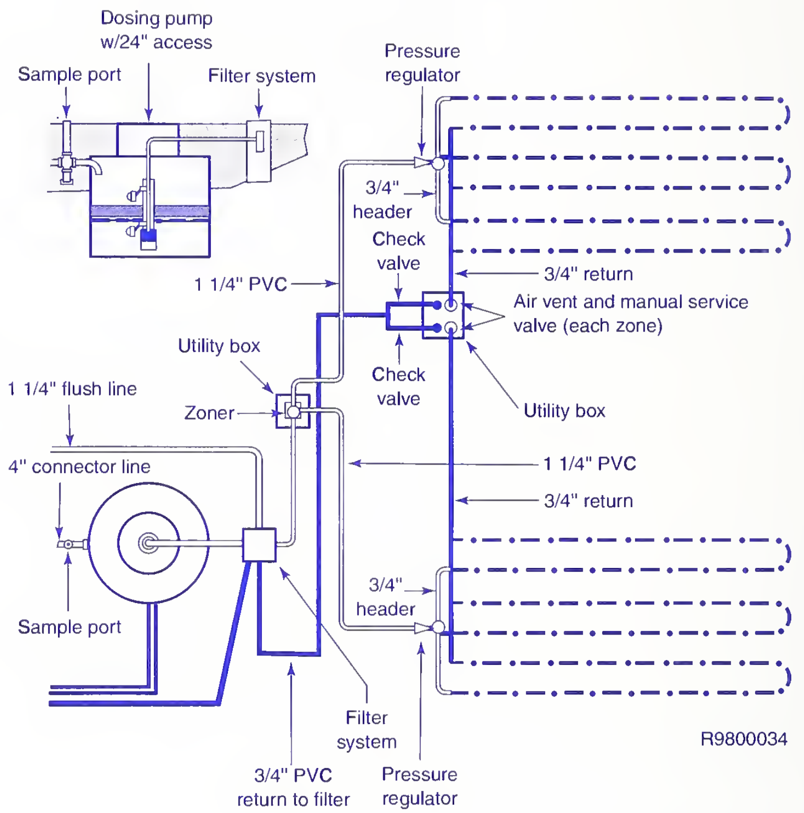
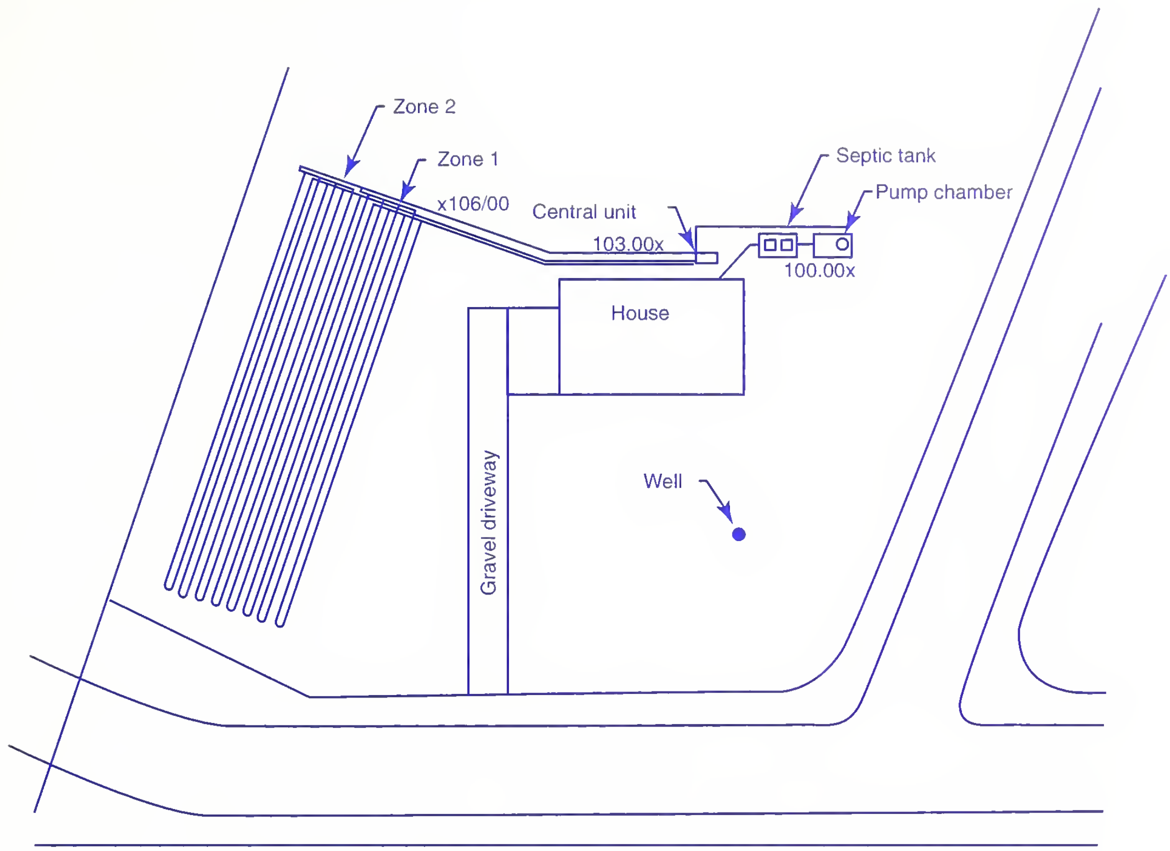


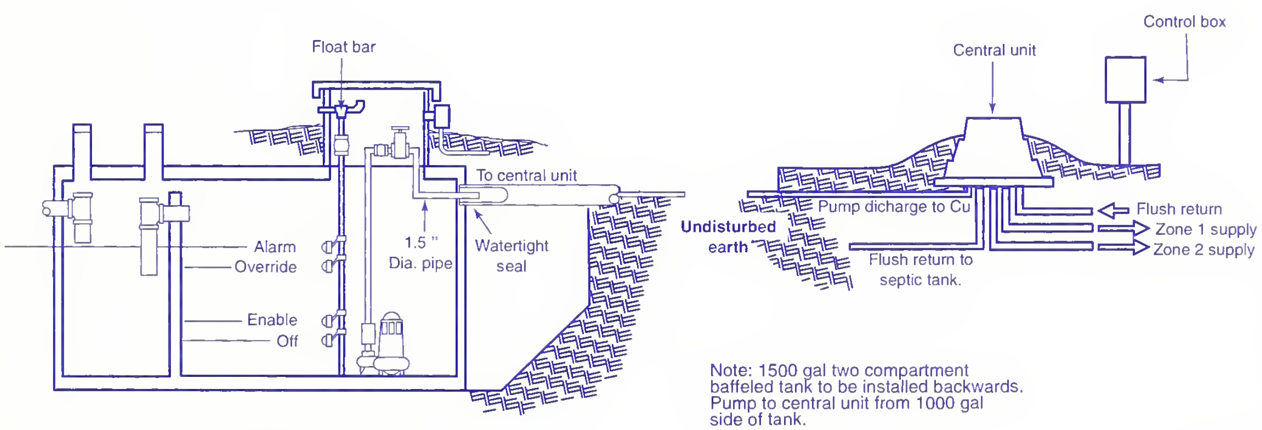
Figure 27—Emitter system.

Dual distribution systems, with reclaimed water for the nonpotable supply, are increasingly being adopted where water resources are limited. Forest Service planners/designers should consider dual distribution systems among the options available to them for addressing water supply needs, water pollution control problems, or both, where regulations allow.

RECOMMENDATIONS

Many issues can be resolved by using new technologies and innovative approaches to water resources management. It is best to approach wastewater treatment as "water reclamation" that produces a useful resource (water and plant nutrients) rather than as a liability. The use of on-site greywater recycling and combined wastewater treatment and recycling systems should always be considered.





Drip Pump Tank Detail

NTS

Figure 28—Emitter system continued.

APPENDIX

APPENDIX
GLOSSARY

The following words and terms, when used in this report, shall have the following meanings, unless the context indicates otherwise.

Aerobic digestion—The bacterial decomposition and stabilization of sewage in the presence of free oxygen.

Anaerobic digestion—The bacterial decomposition and stabilization of sewage in the absence of free oxygen.

Blackwater—All sewage (other than greywater) that contains sufficient human or animal wastes to require the water to be treated prior to disposal.

Collection system—An on-site sewage collection network connected to a treatment and disposal system that is designed to serve two or more sewage generating units.

Effluent—Sewage, water, or other liquid, partially or completely treated or in its natural state, flowing out of a reservoir, basin, or treatment plant.

Floodplain (100 year)—That area along a stream inundated during the time the stream is subject to the statistical 100-year flood.

Geotextile filter fabric—A non-woven fabric suitable for wastewater applications.

Greywater—Wastewater (sewage) from dishpans, clothes washing machines, showers, bathtubs, handwashing lavatories, and sinks not used for the disposal of excreted wastes or hazardous or toxic ingredients.

Injection well—A hole drilled into permeable soil which is intended to receive either raw sewage or the effluent from some form of sewage treatment process.

Low-flow fixtures—Shower heads, faucets, valves, and hose bibs that allow only small quantities of water to pass through.

Low-flow toilets—Toilets that use 1.6 gallons or less per flush.

Mound system—A soil absorption system which is installed in or below an artificially created mound of earth.

National Sanitation Foundation (NSF)—International Testing Laboratories, Ann Arbor, MI. It is a neutral agency, serving government, industry and consumers in achieving solutions to problems relating to public health and the environment. NSF standards specify the requirements for the products, and may include requirements relating to materials design, construction, and performance.

On-site sewage system—A single or combination of treatment devices and disposal facilities that is used only for the disposal of wastewater on the site.

Scum—A mass of organic and/or inorganic matter which floats on the surface of sewage.

Septic tank—A watertight covered receptacle designed to receive, store and provide treatment to domestic sewage. Its function is to separate solids from the liquid, digest organic matter under anaerobic conditions, store the digested solids through a period of detention, and discharge the clarified liquid effluent to be disposed of in an approved sewage disposal facility.

Sewage—Water which contains, or which has been in contact with, organic or inorganic contaminants such as: human or animal wastes, vegetable matter, cooking fats and greases, laundry and dishwashing detergents, and other chemicals, compounds and waste products.

Sludge—A semi-liquid mass of partially decomposed organic and inorganic matter which settles at/or near the bottom of a receptacle containing sewage.

Soil-absorption system—A subsurface method for the disposal of partially treated sewage which relies on the soil's ability to absorb moisture and allow its dispersal by lateral and vertical movement through and between individual soil particles.

Subsurface sewage facility—A system designed to treat sewage and distribute the treated sewage effluent into a below ground-level disposal area.

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SUGGESTED READING

"National On-site Wastewater Recycling Association." Fact sheets about septic systems and record-keeping forms; information about state and regional wastewater associations; 800-966-2942.

"Water Pollution - Information on the Use of Alternative Wastewater Treatment Systems, 9/94." The publication number is GAO/RCED-94-109. The first copy of this report is free. U.S. Government Accounting Office, P. O. Box 6015, Gaithersburg, MD 20884-6015. 202-512-6000, fax: 301-258-4066.

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OTHER SOURCES OF INFORMATION

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235
(303) 794-7711

The National Small Flows Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV 26506
(800) 624-8301

U.S. Environmental Protection Agency
401 M Street SW
Washington, DC 20460
(202) 260-2090

Water Environment Federation
601 Wythe Street
Alexandria, VA 22314
(800) 666-0206

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